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## ANNUAL RAINFALL VARIABILITY MAPS OF THE UNITED STATES

By EARL E. LACKEY

[University of Nebraska, Lincoln, Nebr., November 1938]

The series of rainfall maps herewith described involve the weather records of 2,077 stations in the United States. Only a few records were used that were not up to date, and none which included fewer than 20 consecutive years. A small number of records ran to more than 100 years.

In some rugged areas where stations were scarce and where a real distribution of rainfall was very uneven, a few stations with broken records or records shorter than 20 years were used.

In comparatively level areas the placing of isohyets was an easy task, but in areas of great relief a resort to inference and interpolation was imperative.

The five maps were constructed on the basis of quartile deviations. In order to do this the numerical record by years for each station was arranged in an ascending sequence and then the 0-, 25-, 50-, 75-, and 100-percentile points in the distribution were computed in inches.

In the distribution for any station the 100-percentile point indicates that the precipitation was equal to or more than the given amount 100 percent of the time. This value represents the least rainfall the station ever has received; that is, the minimum. When the minimum figures for each of the 2,077 stations were written on a map of the United States and isohyets drawn connecting

points of equal amounts, a map of the minimum annual rainfall of the United States (figure 1) was obtained.

The 0-percentile values in the distribution represent maximum rainfall; that is, the precipitation was more than the designated amount 0 percent of the time. Stated in another way, this value represents the most rainfall the station has received during the time of record. When the maximum values for the 2,077 stations were placed on a map and the isohyets drawn, a map of the maximum annual rainfall of the United States (figure 5) was obtained.

In a similar manner, the 3d quartile (75 percent), median (2d quartile, 50 percent), and 1st quartile (25 percent) values in each of the 2,077 distributions were represented on maps of the United States; these are reproduced here as figures 2, 3, and 4, respectively.

When the five maps of annual rainfall variability are consulted, it is found that Baltimore has always received 21.6 inches or more (minimum);<sup>1</sup> that 75 percent ( $\frac{3}{4}$ ) of the time the precipitation was equal to or more than 34.4 inches; 50 percent ( $\frac{1}{2}$ ) of the time, equal to or more than 40.6 inches; 25 percent ( $\frac{1}{4}$ ) of the time, equal to or more than 46.7 inches; and 0 percent of the time, more than 62.4 inches (maximum).

<sup>1</sup> The figures given here were taken from the computed distribution. However, readings from the maps should not depart far from these values.

## THERMAL ASPECTS OF THE HIGH-LEVEL ANTICYCLONE

By THOMAS R. REED

[Weather Bureau Office, San Francisco, Calif., September 1938]

The warm-season phenomenon of an anticyclone in the upper air over the North American continent was pointed out a number of years ago by the writer<sup>1</sup> and he assumed at the time that it was thermally induced.<sup>2</sup> High temperatures at the surface were believed to be the principal cause, the inference being that when the lower atmospheric strata became warmed, due to the high surface temperatures prevailing over the western highlands in midsummer, the ensuing expansion produced a convexity in the higher isobarometric surfaces, which in turn set up an anticyclonic flow of winds around the high level "dome" thus created. The clockwise flow was revealed by synoptic studies of

resultant winds at levels of 3,000 m. and higher, the circulation of which was found to conform with a fair degree of consistency to an anticyclonic pattern, centered in a majority of cases over the southern Rocky Mountains.

But while the statistical existence of the high-level cell seemed well supported by theory and observation, there was, initially, no direct evidence of its thermal structure. Subsequently, however, such evidence has become available. The data from airplane soundings which have accumulated in recent years have supplied it, and the purpose of the present paper is to set forth some of this information and show its relation to the phenomenon in question.

First, in support of the assertion that the high-level anticyclone is essentially a thermal phenomenon, let us examine the pattern of mean free-air isotherms in the midsummer months. (Figures 1 and 2). Free-air temperatures for July and August alone are considered, because the high-level "cell" is fully established only in those months, although it may be, and frequently is, in evidence in other months when surface temperatures are abnormally high and the prevailing westerlies relatively

<sup>1</sup> Thomas R. Reed, The North American High Level Anticyclone, MONTHLY WEATHER REVIEW, Nov. 1933, vol. 61, 321.

<sup>2</sup> Recently in an admirable contribution to the subject, Rossby has sought to account for the existence of this and similar anticyclones as dynamically, rather than thermally, induced eddies; and Namias has illustrated the application of the theory by an exegesis of isentropic movements associated with examples of the current systems involve. No doubt both factors play a part, but in the anticyclone under discussion the thermal factor seems to the writer paramount. Unfortunately this aspect is not yet susceptible of adequate isentropic treatment for two reasons: (1) the fewness of upper air sounding stations west of the 100th meridian and (2) the altitude of the available soundings, their height not being sufficiently great to permit the construction of isentropic charts at effective levels in the free air. For discussion of the dynamical theory see Rossby, Namias, and Simmers: Fluid Mechanics Applied to the Study of Atmospheric Circulations, Papers in Physical Oceanography and Meteorology, Vol. VII, No. 1, published by Massachusetts Institute of Technology, Cambridge, Mass., 1938.



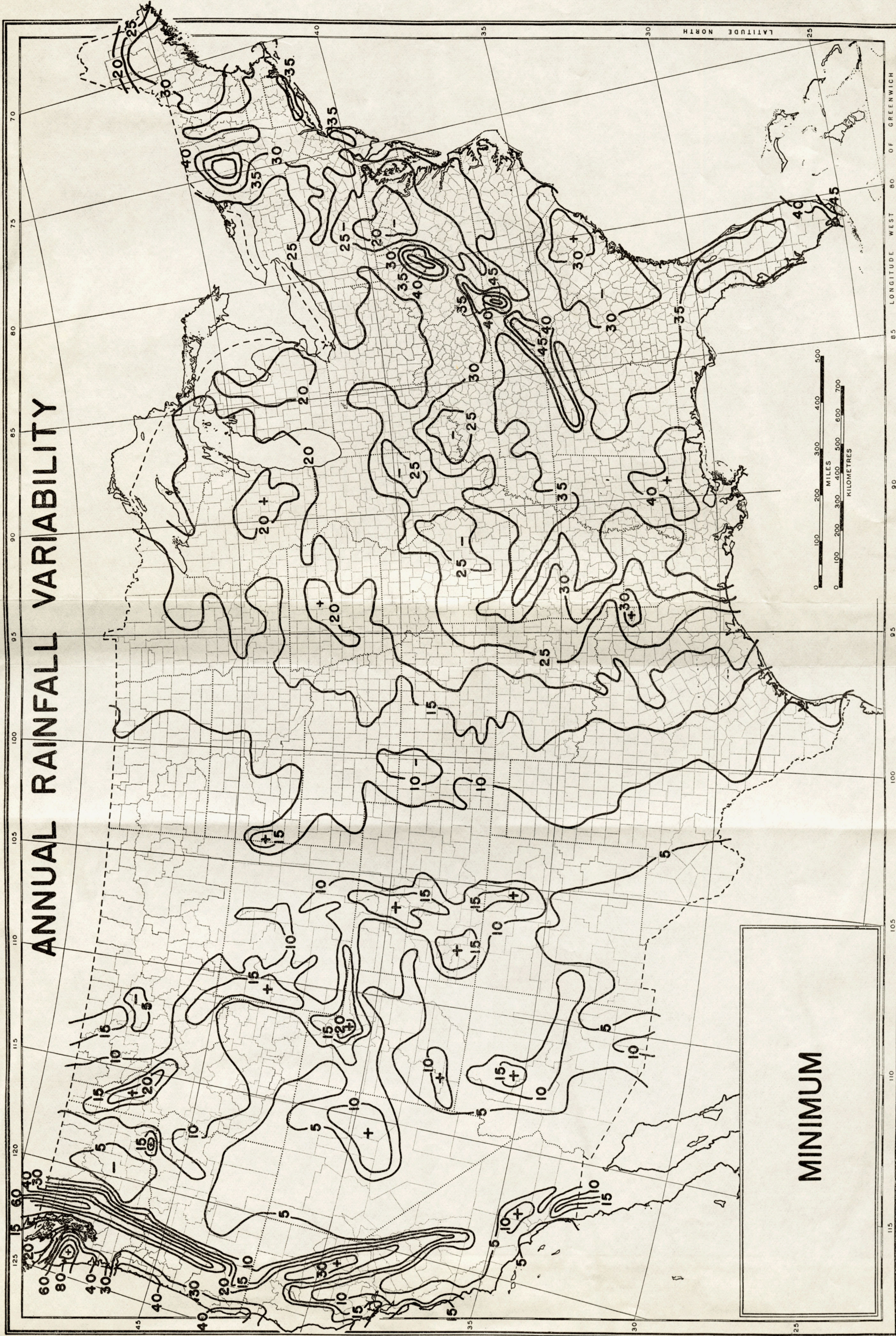


FIGURE 1.





FIGURE 2.



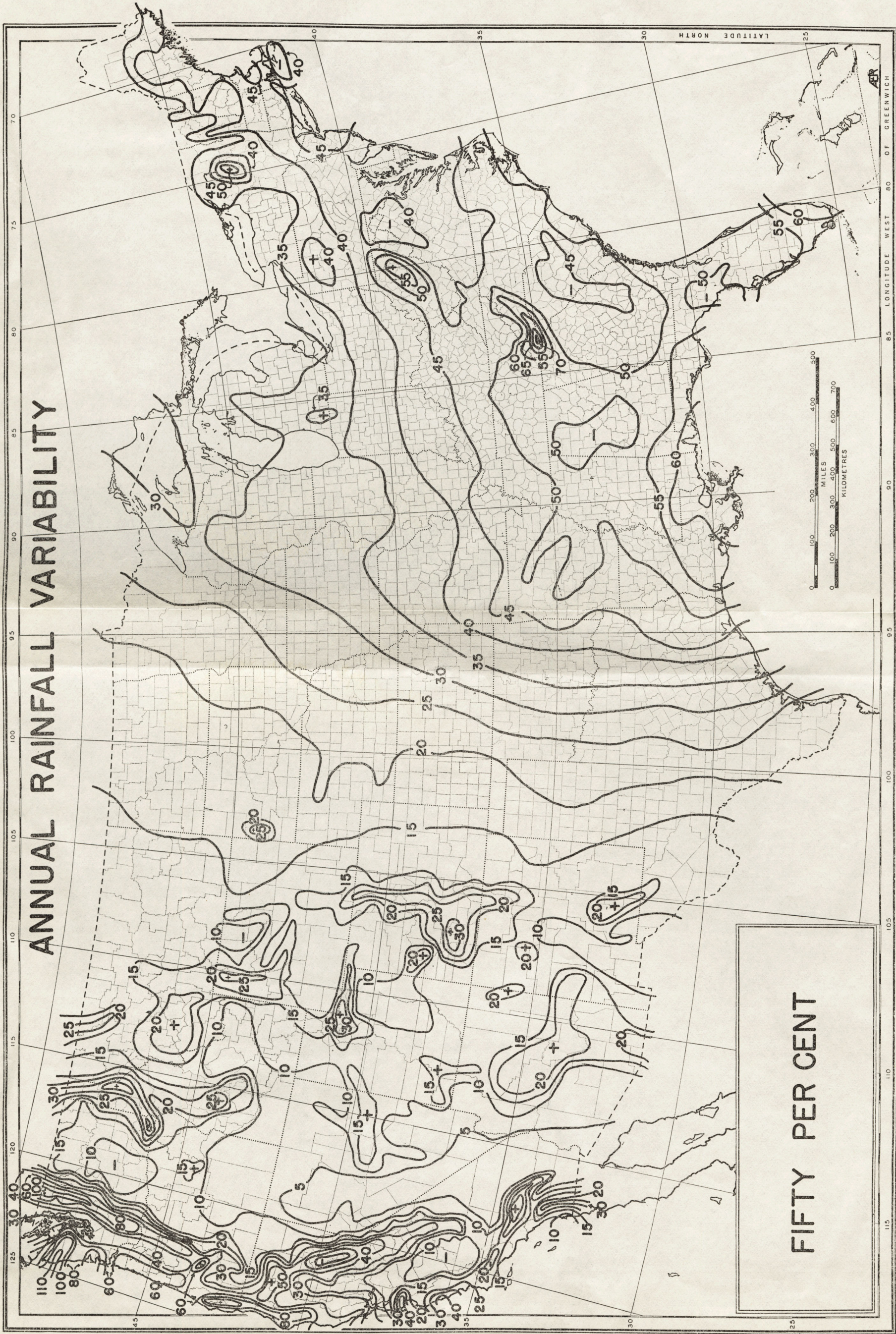


FIGURE 3.



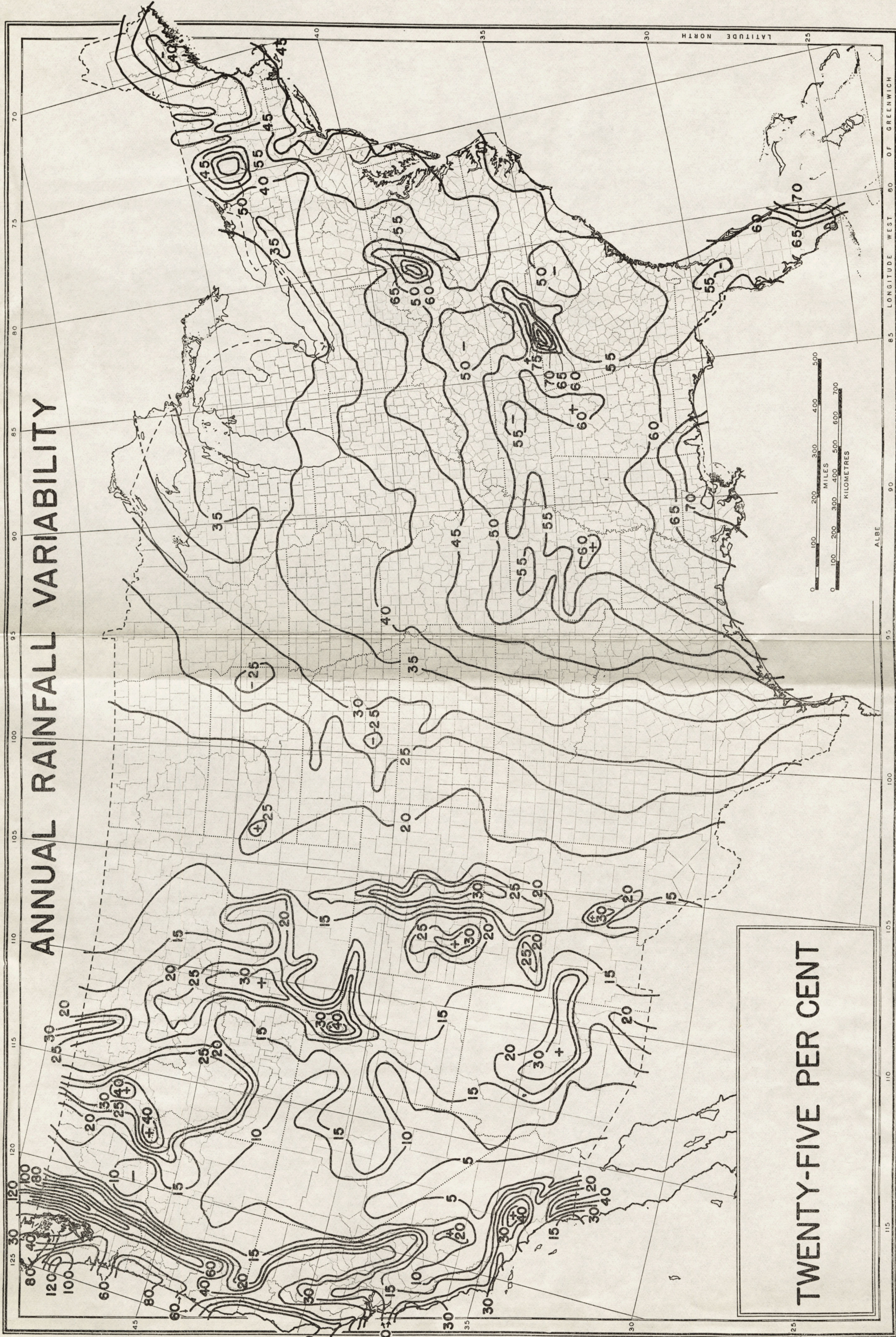


FIGURE 4.





FIGURE 5.